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(54) Method and apparatus for by cutting up fibre string into fibre cuts dosing the latter into a concrete mixture.

(57) A method and an apparatus for adding to a concrete mixer a desired quantity of fibre cut e.g. of plastic. The apparatus comprises a concrete mixer (5), a magazine (16) for storing a number of spools (15) with fibre string (12), and a cutter (9) for advancing during the dry mixing the fibre string and cutting it into predetermined lengths which are fed to the concrete mixture in an even and uniform flow. The apparatus also comprises at least one sensor (20) for sensing the feeding speed of the fibre string and giving off signal to a control unit (not shown) which again controls the feeding speed. By way of the invention it is possible to achieve a far more even and more uniform distribution of the plastic fibres in the finished concrete than known before, whereby the material improving properties of the plastic fibres are optimally exploited.

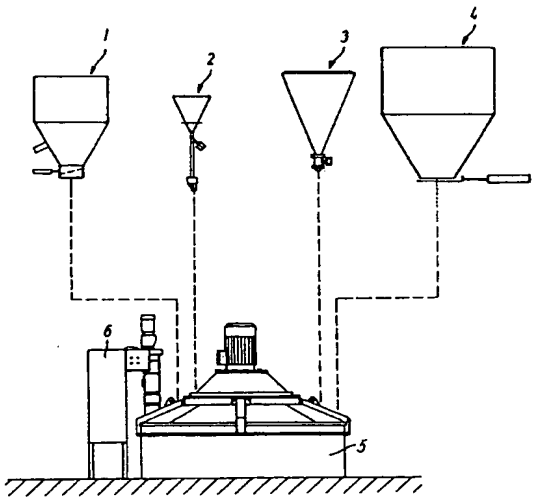

FIG. 1

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The invention relates to a method of adding to a concrete mixture a desired quantity of fibre cuts of e.g. plastic, and the mixing process comprises dosing aggregates in the form of sand and stone, as well as dry mixing, dosing cement and additives under continued dry mixing, dosing additives and water, as well as wet mixing, and discharging the finished concrete mixture, whereby fibre string is advanced by means of a feed mechanism to a cutter for cutting the string into predetermined lengths which are fed to a concrete mixer with the concrete mixture.

Like reinforcing irons, fibres of various kinds have for many years advantageously been used to increase the tensile strength of concrete. When the fibres are of plastic, e.g. polypropylene, there are additionally obtained other significant advantages.

In the low-dosing area, where 1-3 kg fibres/m^3 concrete are added, the plastic fibres thus prevent visible shrinkage cracks by limiting the development of micro-cracks. Especially during the first phase of the hardening, concrete normally undergoes a volume reduction causing formation of micro-cracks. The presence of the plastic fibres entails that this crack-formation is counteracted, and that the concrete develops its full potential strength and impermeability. The fibres change the intrinsic structure of the concrete, and a crack-free product is obtained which does not call for provision of traditional shrinkage reinforcement nets.

In the high-dosing area, where 10-20 kg fibres/m^3 cement bound material are added, the fibres additionally impart a decided reinforcing effect to the material, whereby its tensile strength, tenacity and energy of rupture are significantly increased. When the fibre reinforced object is loaded in excess of the bearing capacity of the unreinforced material, countless evenly distributed stable micro-cracks are formed, but the presence of the fibres entails that this crack-formation does not lead to fracture until at a significantly higher load.

The even distribution of the micro-cracks necessary for obtaining the above advantageous properties is, however, contingent on a correspondingly even distribution of the plastic fibres. These fibres, however, have very small density as compared with e.g. the aggregates stone and sand, and besides, the fibres take up negligible space in comparison with the total concrete mass. Consequently, it has been extremely difficult to achieve a sufficiently even distribution of the fibres by means of the commonly used dosing method where the fibres are merely batch-wise poured manually into the concrete mixture.

An improved method is known from Swiss patent specification No. 460.620 where fibre cuts from a cutter are added to a concrete mixture during the mixing process. Nor by this method has it, however, been possible to achieve a satisfactorily even distribution of the fibres in the mixture, since the quantity of fibres added during the wet mixing because the water content tends to stick to the aggregates in the local area where the fibre cuts fell into the concrete mixture. Consequently, further distribution to the rest of the concrete mixture can only take place to a very limited extent.

It is the object of the invention to provide a method of the kind stated in the introduction by which the fibres are automatically distributed more evenly and uniformly in the concrete mixture than known before.

The novel and characteristic feature of the method according to the invention is that the fibre cut is fed into the concrete mixer during the dry mixing. This ensures that the fibres already during the dosing proper become evenly distributed in the material, since the latter successively under simultaneously mixing passes under the area or areas at the surface of the concrete mixture where the fibres are added, and that the fibres are not hereby bound by moisture to the aggregates, but on the contrary can move freely in relation thereto.

The fibre flow to the concrete mixer is advantageously controlled by controlling the feeding speed of the fibre string, since this speed is sensed by means of a sensor which gives off to a programmed control unit a signal representing the feeding speed, which is thereby again controlled by the control unit.

The invention also relates to an apparatus for adding to a concrete mixture a desired quantity of fibre cut e.g. of plastic, and comprising an aggregate silo, a cement silo, an additive silo and a water silo or similar water supply, as well as a concrete mixer, and additionally a supply of fibre string, a feed mechanism for the said fibre string and a cutter for cutting the fibre string into predetermined lengths.

In view of automatically controlling the flow of the fibre cut added to the concrete mixer the plant according to the invention further comprises at least one sensor for sensing the feed speed of the fibre string and a programmed control unit for regulating in dependence of the signal from the said sensor the feeding speed, so that the desired quantity of fibre cut is added to the concrete mixture in an even flow during the dry mixing.

According to an advantageous embodiment the cutter is positioned at a level above the mixer, whereby the fibre cut by itself in finely distributed form sifts down into the mixer through an air duct. In this duct there is a gate which normally bars communication from the concrete mixer up to the cutter, which is hereby spared attacks by dust and moisture which could otherwise rise through the air duct and attack the cutter. The gate is then only opened when the desired quantity of fibre cuts is to be added to the mixture.

Alternatively, the cutter can be positioned above a conveyor or an air duct between the cutting machine and the mixer. This allows the cutting proper to take place at some distance from the mixing process,

which may often be advantageous. Thus, the cutting of the fibre string and a supply thereof may e.g. be placed in another room or in another storey.

The fibre string proper is normally wound into spools which in a suitable number are placed in a magazine from where the cutter itself normally fetches the strings. When the spools run out of string the magazine must be refilled with spools, which means that in the meantime the entire mixing process is interrupted. To avoid this, the apparatus may comprise at least two exchangeable magazines, so that one can be filled while the other operates. According to another solution the concrete mixer may be connected to several complete apparatus which are used in turn.

The invention also relates to an apparatus for adding to a concrete mixture a desired quantity of fibre cuts e.g. of plastic. This apparatus comprises a concrete mixer, a magazine for storing a supply of fibre string, a feed mechanism for advancing the fibre string during a predetermined period of each mixing cycle, a cutter for during this period successively cutting the fibre string into predetermined lengths, and a conveyor for feeding these lengths to the concrete mixer in an even flow.

In view of automatically controlling the flow of the fibre cuts added to the concrete mixer, the apparatus according to the invention additionally comprises a sensor for sensing the feeding speed of the fibre string and a control unit for regulating in dependence of the signal from the sensor the feeding speed, so that the desired quantity of fibre cuts is added to the mixture in the desired even flow.

In the following the invention is explained in more detail by way of examples of embodiments, reference being made to the drawing in which

Fig. 1 shows a side-view of an embodiment of a complete apparatus according to the invention,

Fig. 2 shows in a larger scale and partly in section a cutting arrangement appertaining to the apparatus shown in fig. 1 for cutting up fibre string immediately in connection with the mixing process,

Fig. 3 shows schematically the principle of the cutting arrangement shown in fig. 2,

Fig. 4 shows a side-view of a segment of the cutter appertaining to the cutting arrangement shown in fig. 3 in the process of cutting a fibre string,

Fig. 5 shows a first embodiment of the apparatus according to the invention where the fibre cut by gravity sifts directly down into the concrete mixer,

Fig. 6 shows a second embodiment of the apparatus accord ing to the invention where the fibre cut is passed to the concrete mixer by means of a belt conveyor,

Fig. 7 shows a third embodiment of the apparatus accord ing to the invention where the fibre cut is passed to the concrete mixer by being blown through an air duct by means of a blower,

fig. 8 shows a top view of the apparatus shown in fig. 5,

Fig. 9 shows the same, but with three exchangeable magazines, and

Fig. 10 shows an apparatus according to the invention with three cutting arrangements.

Fig. 1 shows a complete apparatus for mixing concrete and adding a predetermined fibre cut portion to the mixture. The raw materials used for this mixture are in this case stored in four silos which in order of succession from the left is a cement silo 1, an additive silo 2, a water silo 3 and an aggregate silo 4. These siloes which are all of conventional kind, are each closable by a gate, and are furthermore each separate one connected to a concrete mixer 5 via pipe conduits which in the figure are merely indicated by a dotted line. The concrete mixer is further connected to a cutting arrangement which in its entirety is designated by the reference numeral 6 and which serves to cut fibre string into fibre cut and feed the latter to the concrete mixer in the manner further described in the following.

Fig. 2 shows, partly in section, the cutting arrangement 6 shown in fig. 1 in a larger scale, and the same arrangement is also shown schematically in fig. 3. The complete arrangement is, as best seen from fig. 2, positioned in a closed cabinet 7, which via an air duct 8 is connected to the concrete mixer 5, of which only a segment is shown. The arrangement comprises a cutter 9, consisting of a press roller 10 and a cutter head 11. Fig. 4 shows a segment of this cutter in a larger scale in the process of cutting a fibre string 12 to fibre cuts. The fibre string 12 is wound a couple of turns around a row of radially positioned knives 12 positioned in equally spaced relationship along the periphery of the cutter head 11. The press roller 10 is urged with a suitable pressure against the cutter head 11, whereby the immermost one of the turns of the fibre string is cut through by the knives 13 and drops down between the latter as fibre cut 14. Since the fibre string 12, as mentioned, has been wound several turns around the cutter head 11 the latter will itself automatically attract the fibre string in step with the cutting up.

In reality, the cutter 9, as shown in fig. 2 and 3, is simultaneously provided with several strings at a time. These strings have been wound into a number of spools 15 accomodated in a magazine 16 which is part of the complete cutting arrangement 6. From the spools 15 the fibre strings have been passed e.g. through eyes 17 (fig. 3) or over reels 18 (fig. 2) for guiding the strings on their way to the cutter 9, which, as mentioned, by itself attracts the strings as needed. In the air duct 8 there is a gate 19 which is opened by dosing, but is normally closed to prevent moisture and dust from the mixing process from rising and damag-

ing the cutter 9 or other parts of the cutting arrangement 6. Sensors 20 serve to sense the feeding speed of the fibre strings.

When the concrete is to be mixed, the concrete mixer 5 is first supplied with the prescribed quantity of aggregates in the form normally of stone and sand from the silo 4, a dry mixing hereby taking place, whereafter the cement from the silo 1 is dosed under continued dry mixing. Finally, additives and water from the silos 2 and 3, respectively, are added, and after wet mixing of the entire concrete mixture it is now ready for discharge from the concrete mixer 5.

It is usually rather large amounts of materials which are added to and mixed in the concrete mixer in a very short time during the performance of the above process stages. Compared with these large amounts of material the addition of e.g. plastic fibres to fibre concrete constitutes an infinitesimal fraction which it is difficult to distribute evenly in the concrete mixture merely by batch-wise pouring it manually and at random into the latter, in the way it has previously generally been done.

As mentioned in the introduction of the present specification an addition of plastic fibres is capable of considerably improving the material properties of the finished concrete i.a. by distributing any crack-formations into a finely meshed net of unharmful microcracks. The precondition for optimal exploitation of this effect is, however, precisely that the fibres are distributed very evenly in the concrete mixture. Is this not so, the finished concrete will easily become inhomogeneous. In some areas the concrete will thus not have attained the prescribed improvements of the material properties due to lack of fibres, whereas other areas where the fibres lie too close, have become directly weakened, since the fibres in more or less coherent quantities form interfaces which are incapable of transferring tensile forces in the finished concrete construction.

To improve the mixing the fibres are advantageously added during the dry mixing which treats the largest amount of materials, and during which the material still has a comparatively loose and easily workable structure. In the short time available during this mixing, and which lies within the range about 1/4 - 1 1/2 min, it is important that the plastic fibres get into contact with as much of the concrete mixture as possible immediately during the dosing proper if a satisfactorily uniform distribution of the fibres in the mixture is to be achieved. When first the fibres have been worked into the mixture they can as a result of their lightness and relatively large surface only with difficulty be displaced relatively to the far heavier content of stone and sand in the mixture.

To achieve uniform distribution of the fibres in the mixture the fibres are thus according to the invention added in an even and constant flow over a period which, as mentioned, advantageously may span most of the dry mixing period. Thereby all parts of the concrete mixture will as a result of the mixing process little by little pass under the zone in which of the fibres fall down into the concrete mixer, and in this way at once become intimately distributed throughout the entire concrete mass.

By the apparatus according to the invention this is e.g. achieved during the dry mixing period by advancing the fibre strings at a constant speed which precisely corresponds to the desired quantity of fibre cut per time unit. The speed is sensed by means of the sensors 20 which give off signal to a programmed control unit (not shown).

This control unit may be equipped with a keyboard for coding in the data and desired material properties of the various mixtures, whereafter the control unit by means of its program automatically readjusts the number of revolutions of the cutter head 13, so that the cutter advances the fibre strings 12 at correct speed and cuts them into predetemined lengths which in the course of the dry mixing period sift down into the concrete mixture whereby they are evenly and uniformly distributed therein.

The cutter 9 can, as shown in figs. 1, 2, 3 and 5, be accomodated just above the concrete mixer 5, so that the fibre cut falls directly therein via the air duct 8. Because of conditions of space it may, however, sometimes be advantageous if the arrangement 6 is placed at some distance from the concrete mixer 5. In this case a belt conveyor 21 can be installed between the said mixer and the cutting arrangement 6, which conveyor conveys the fibre cut to the concrete mixer 5. As shown in fig. 7 an air duct 22 may also be used for advancing the fibre cut, through which duct the fibre cut is blown by means of a blower 23. In this case the cutting arrangement 6 may e.g. be positioned in another storey also accomodating the supply of fibre string spools.

Fig. 8 is a top view of the complete apparatus provided with only one cutting arrangement 6. By intensive operation the apparatus, as shown in fig. 9, can advantageously also be equipped with exchangeable magazines 16 which are filled when they are not coupled to the cutter. When a magazine is empty it can therefore quickly be replaced by a full magazine so that no time is wasted in operation when a magazine has run out of fibre string and must be supplied with fresh spools. In order to further lower the time wasted, each concrete mixer may be provided with several cutting arrangements 6, as shown in fig. 10. When the arrangement used in a given moment, runs out of string, one of the other cutting arrangements, which in the meantime has been supplied with full spools, can immediately be put into operation.

Claims

1. A method of adding to a concrete mixture a desired quantity of fibre cuts of e.g. plastic, and the mixing process comprises dosing aggregates in the form of sand and stone, as well as dry mixing, dosing cement and additives under continued dry mixing, dosing additives and water, as well as wet mixing, and discharging the finished concrete mixture, whereby fibre string is advanced by means of a feed mechanism to a cutter for cutting the string into predetermined lengths which are fed to a concrete mixer with the concrete mixture, **characterized** in that the fiber cut is added to the concrete mixer during the dry mixing.

2. A method according to claim 1, **characterized** in that the fibre cut during the dry mixing is added to the concrete mixer in an even flow by controlling the feeding speed of the fibre string by means of a programmed control unit in dependence of the signal from a sensor for sensing the feeding speed.

3. An apparatus for adding to a concrete mixture a desired quantity of fibre cut of e.g. plastic, and comprising an aggregate silo, a cement silo, an additive silo and a water silo or similar water supply, as well as a concrete mixer, and additionally a supply of fibre string, a feed mechanism for the said fibre string and a cutter for cutting the fibre string into predetermined lengths, **characterized** in that the apparatus further comprises at least one sensor for sensing the feeding speed of the fibre string and a programmed control unit for controlling in dependence of the signal from the said sensor the feeding speed, so that the desired quantity of fibre cut is added to the concrete mixture in an even flow during the dry mixing.

4. An apparatus according to claim 3 and where the fibre string in the store is kept in a wound state, **characterized** in that the apparatus comprises a magazine with several fibre string spools for each separate fibre string.

5. An apparatus according to claim 3 or 4, **characterized** in that the magazine comprises guide means, such as eyes or reels, for gathering the individual strings from each spool into a string bundle.

6. An apparatus according to claim 3, 4 or 5, **characterized** in that the apparatus comprises several exchangeable magazines and/or separate cutting arrangements.

7. An apparatus according to one or more of the claims 36, **characterized** in that the apparatus comprises a conveyor for conveying the fibre cut to th concret mixer.

8. An apparatus according to claim 7, **characterized** in that the conveyor comprises an air duct between the cutter and the concrete mixer.

9. An apparatus according to claim 8, and where the cutter is accomodated at a level above the concrete mixer, **characterized** in that there is a gate in the air duct which is normally closed, but is openable when the desired quantity of fibre cut is to be added to the concrete mixture.

10. An apparatus according to claim 7, **characterized** in that the conveyor is a belt conveyor installed between the cutter and the concrete mixer.

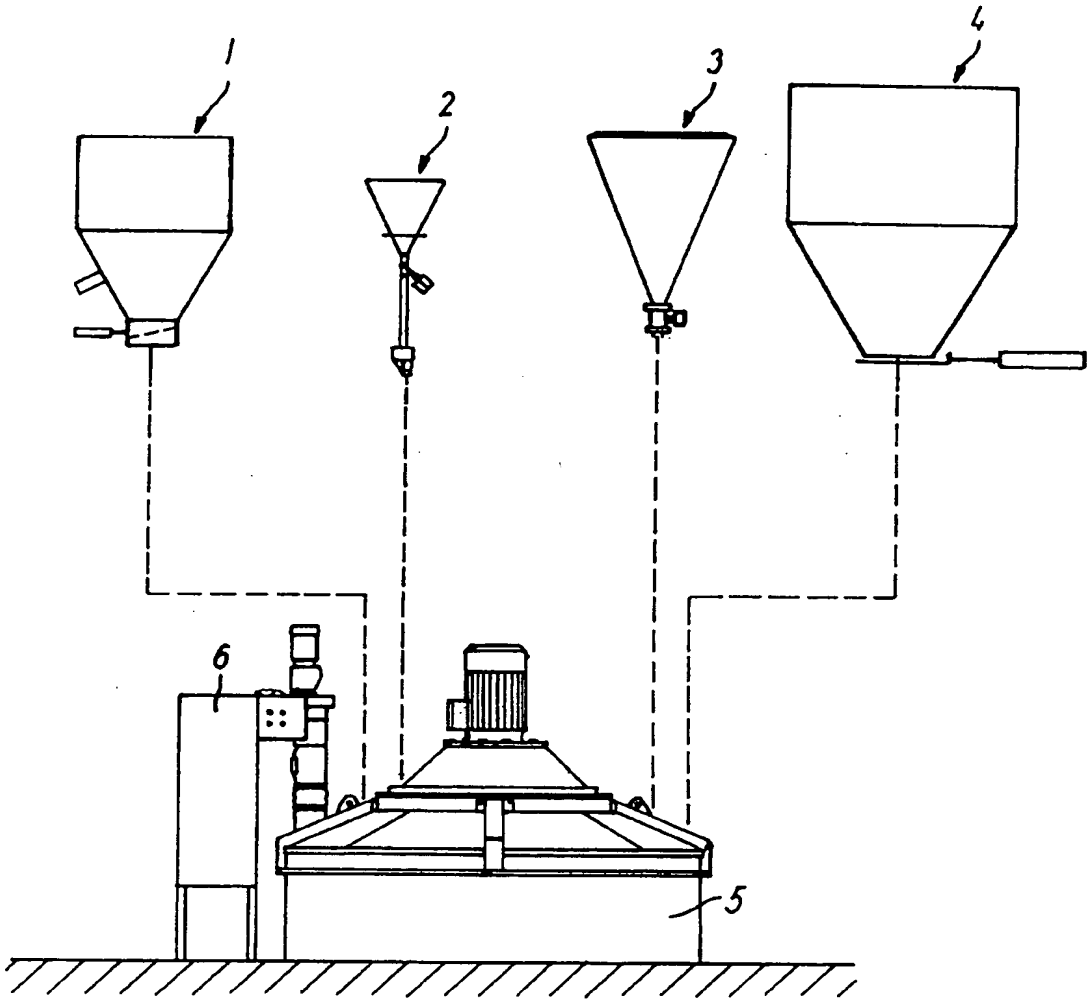

FIG. 1

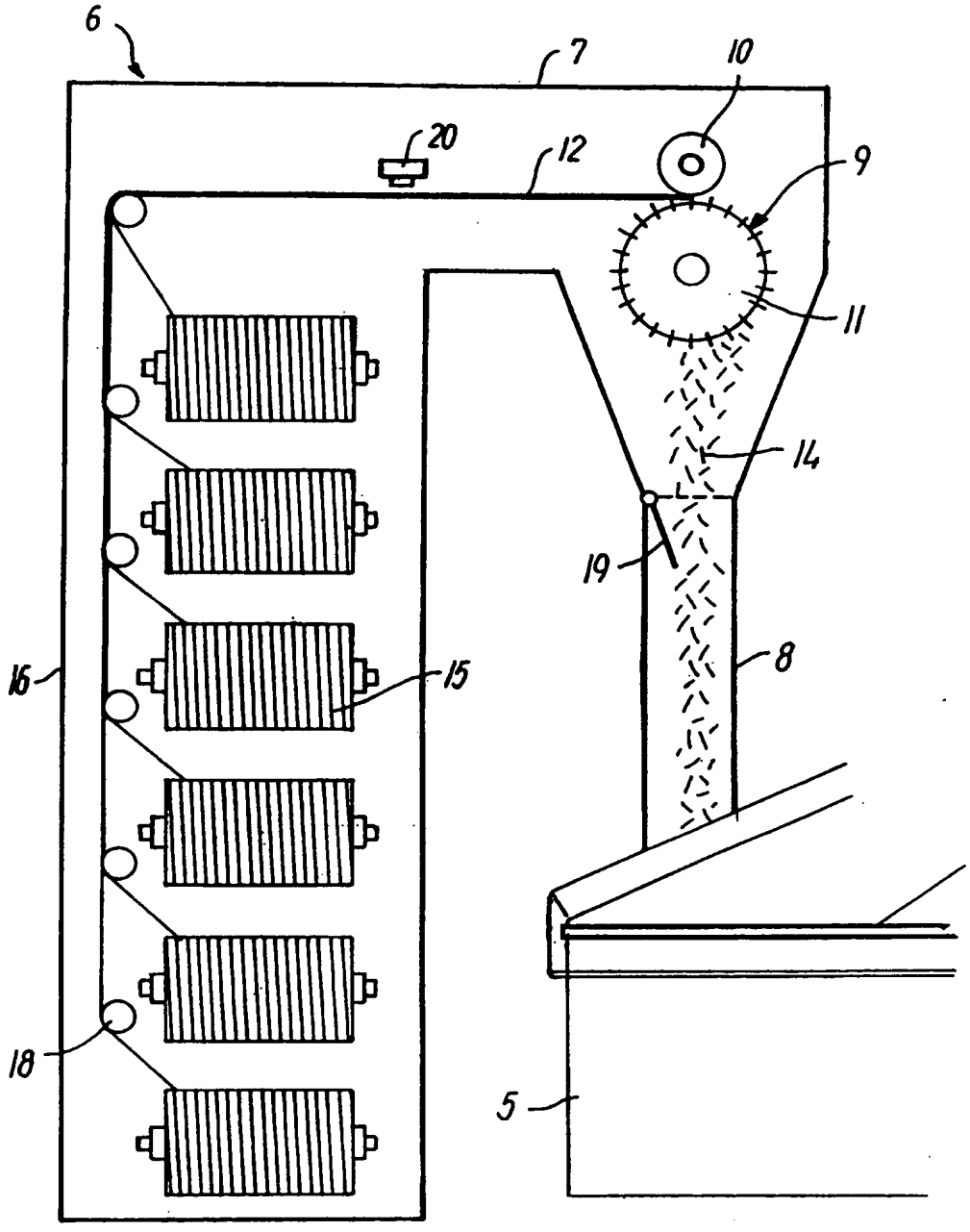

FIG. 2

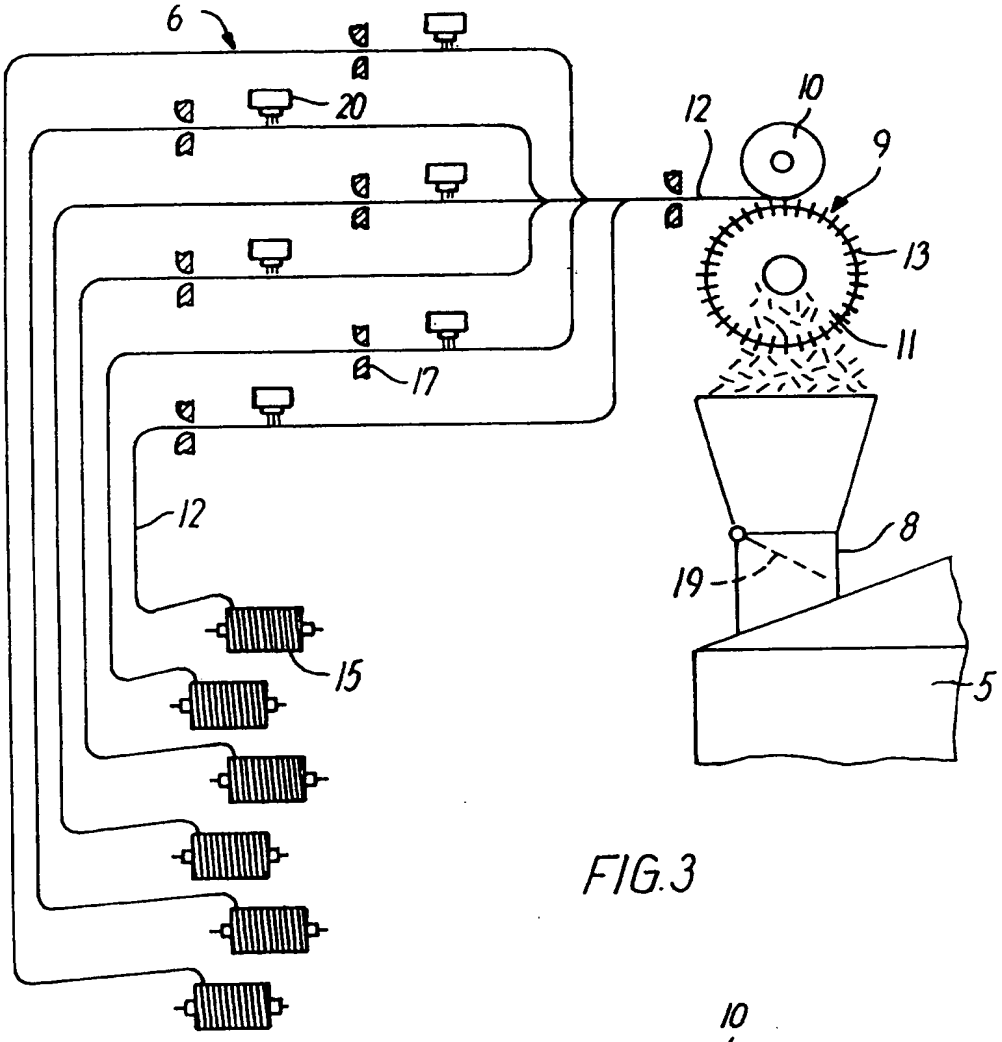

FIG.3

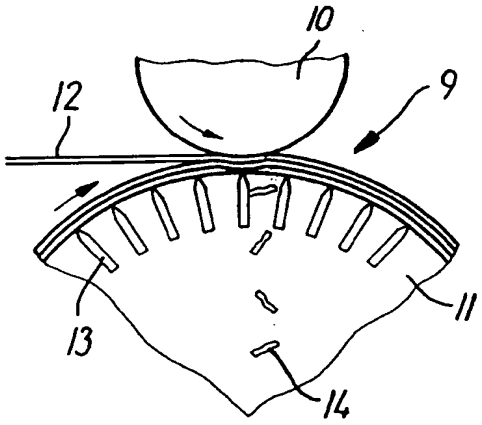

FIG.4

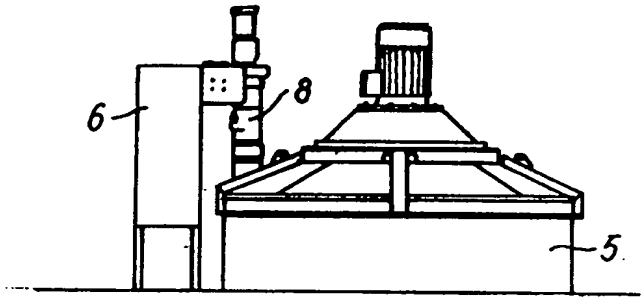

FIG.5

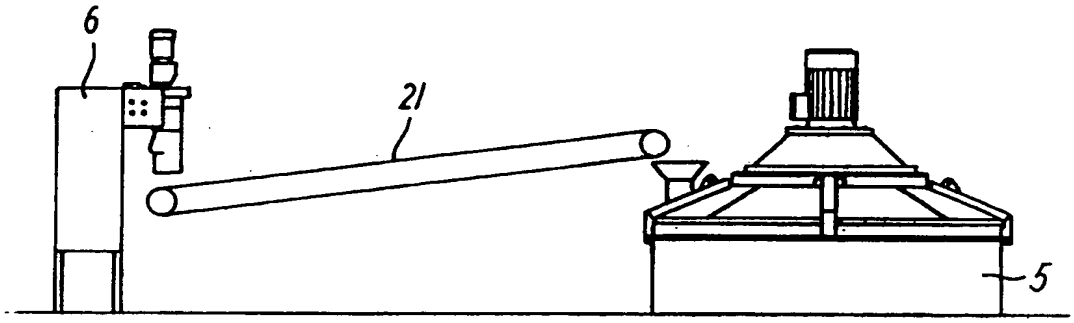

FIG.6

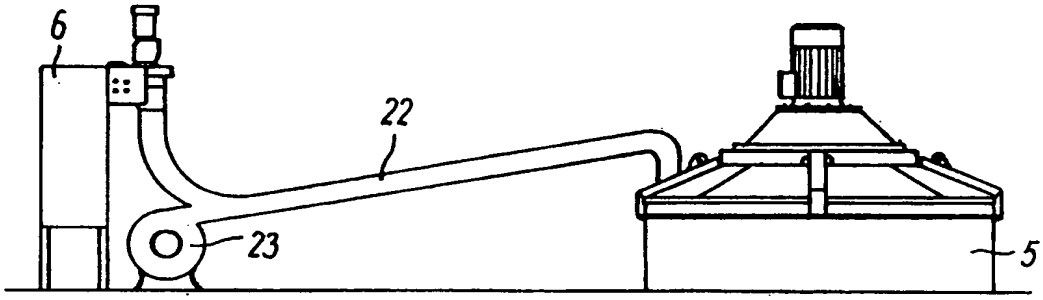

FIG.7

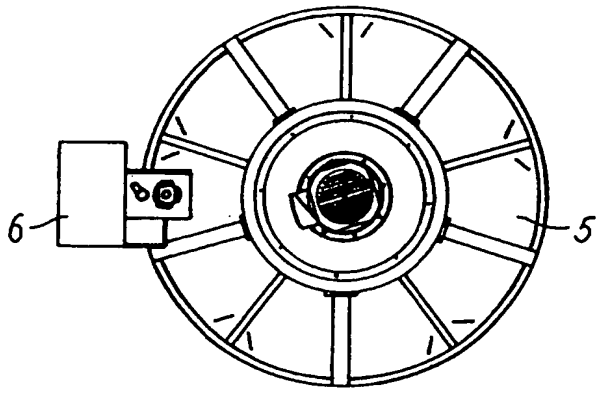

FIG. 8

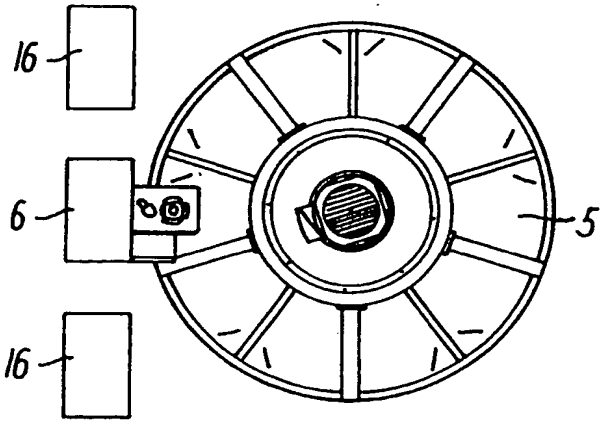

FIG. 9

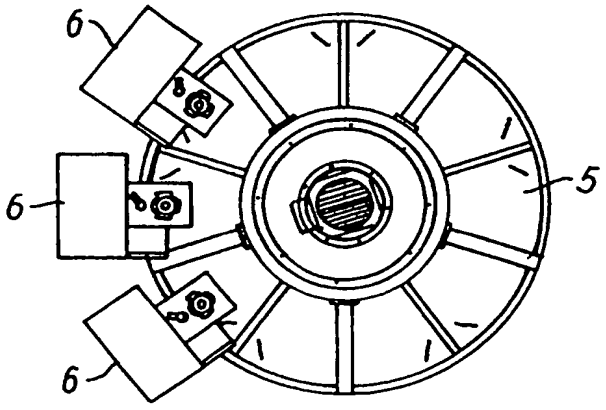

FIG. 10

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 92610009.0

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.)
X	CH-A- 460 620 (COMPAGNIE DE SAINT-GOBAIN) *Figure 2*	1-3,5	B 28 C 5/40 B 28 B 1/52
A	GB-A-1 469 424 (ONODA CEMENT COMPANY LIMITED) *Figure 1, detail 12*		

TECHNICAL FIELDS SEARCHED (Int. Cl.)

B 28 B
B 28 C
E 04 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
STOCKHOLM	07-04-1992	JUVONEN V.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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